JSAES
Journal of Sustainable Agricultural and Environmental Sciences

Print ISSN : 2735-4377
Online ISSN : 2785-9878
Homepage: https://jsaes.journals.ekb.eg/

Research Article

Implementation of Food Safety Management System FSMS (ISO 22000) in Cold Smoked Herring (*Clupea harengus*) Factory at AL-Gharbia Governorate

Maha M. Zalat*, Mohamed B. Atta and Mohamed R. Badr

Food Science and Technology Department, Faculty of Agriculture, Tanta University, Egypt
*Corresponding Author: **mahazalat97@gmail.com**

Article info: -

- **Received:** 11 April 2024
- **Revised:** 4 May 2024
- **Accepted:** 11 May 2024
- **Published:** 30 May 2024

Keywords:
Cold smoked herring; Hazard; HACCP; Corrective action; ISO.

Abstract:

This study depends on the importance of implementation of Food Safety Management System (FSMS), Critical Control Points Hazard Analysis (HACCP) and the Prerequisite Programs (PRPs) as the substance of HACCP in the factory of cold smoked herring fish, to stop foodborne disease outbreaks and to make the food safe to the consumer through implementing of good food safety principles and avoidance of cross- contamination and fraud. This implemented system organized preventative methods to care for foods and consumers from contaminants that may be physical, chemical, and biological. It is regularly applied in all food production stage, beginning with received raw materials from approved suppliers, within food production processing stage and after finishing production processing i.e. distribution of final products to customers, to make sure there is no hazard in the products or to reduce the hazard in the safe level that does not cause any risk for human when consumption it (i.e. safe food consumption when people eat it). The results showed the difference between biological examination (swabs was taken from equipment in salting area and packaging area, swabs were taken from worker's staff in salting area and packaging area) before and after ISO implementation through application of programs of cleaning and disinfection and individual hygiene. Also, water supply quality and safety were implemented by microbiological analysis of water. The final products that ready – to – eat called cold smoked herring fish were analyzed chemically, microbiologically, physically and sensory to ensure the safety and quality of them.

1. Introduction

In recent times, buyers have absorbed on food safety, which prevent infection, microbial contamination or else poisoning. Food safety becomes a main and critical standard for buyers on the way to select food regardless of its importance and nutritional value. A food safety-risk examination: is necessary not only to produce or manufacturing high quality goods to confirm safety and keep public health, on the other hand also to submit with international and national standards and market regulations. There are three food risks types: physical, biological and chemical (Codex, 2009 and ISO22000, 2018). The ISO 22000 consists of cooperating communication, system management, pre-requisite programs (PRPs), hazard analysis and critical control point (HACCP) principles (ISO 22000, 2018).

Herring fish is careful an excellent food of high-grade protein; due to containing minerals, vitamins, protein and fat (Kari et al., 2020). Besides, it has a high level of polyunsaturated fats (PUFA) that aids in lowering cardiovascular diseases in individuals (Mishra, 2020). This type of fish is used for producing many different types of fish products like dried, salted, canned, marinated and smoked herring (Atef, 2013). Herring fish preservation method like smoking which is a natural old-style method as antioxidant activities of smoked compounds, dehydrating and antimicrobials. This processing provided a golden color and smoke flavor that is very attractive to buyers (Tenyang et al., 2018). While the main role of processing is preservation, processing not only extends shelf life but also creates a new range of products (Blackwell, 2014). Cold smoking is used to impart aroma and flavor in the fish muscle (Doe, 1998). This study objective is to ensure that all products factory-made by the are safe and fit for consumption (our end customer expects that) so food safety as one of the highest priorities in doing business for the reason that it keeps in the long run the business money, avoids customers poisoning and improves workers staff motivation and efficiency. Additionally, implement HACCP plan for cold smoked herring fish products based on optimal conditions in the factory to produce safe product.

2. Materials and Methods

Materials

The present study was carried out at processing and packaging cold smoked herring fish provided from the Gawhara factory at Al-Gharbia Governorate, Egypt, in the spring season of the year 2023.

All chemicals, solvents, media in this study,

were purchased from El-Gomhorea Company for chemicals and drugs, Tanta, Egypt have not yet been obtained at the time of submission, please state that they will be provided during review. They must be provided prior to publication.

Method description

2.1. Proximate analysis determination

The proximate composition (protein, lipid, ash, moisture and carbohydrate) of the smoked herring fish was performed agreeing to the procedures of American Oil Chemists' Society (A.O.C.S, 2005).

2.1.1. Moisture content

Excellently ground (2g) of sample had been weighed into a petri dish of well-known weight. It was dry in a hot air oven at 105°C for 4 hours; afterward the time has gone the sample was carried out and placed inside a desiccator for make cold. The moisture content was calculated by way of:

Moisture % = [(W1 – W2) ×100] ÷ W

W = Sample weight

W1 = Sample weight + Petri dish weight.

W2 = Dried sample weight + Petri dish weight

2.1.2. Ash

5 g of sample was weighed and transferred in pre-weighed porcelain crucible. The weighed sample was burned till smoke ceases. The crucible was then transferred to muffle furnace maintained at 550ºC and incinerated until light grey ash was obtained. The crucible was then cooled in desiccator and weighed. The result was described on dry weight basis.

Ash% = [(W1 – W2) ×100] ÷ W

W = Sample weight

W1 = Sample weight + Crucible weight.

W2 = Ash weight + Petri dish weight (after ash).

2.1.3. Lipid

The dried samples were ground in a blender and 5 g of sample was weighed correctly and moved to the thimble and defatted with petroleum ether in Soxhlet apparatus for six to eight hours at 80°C. The residue was procured and ether was removed through evaporation. A loss in thimble weight was estimated as lipids loss from sample and known as percentage lipids in sample.

Fat % = [loss in sample weight × 100] ÷ Sample weight

2.1.4. Protein

2 g of sample was weighed and set into the tube of digestion. Taken 20 ml of concerted sulphuric acid (98%) and 2 digestion mixture tablets as catalyst had been additional into the tube of digestion. The digestion had been carried out for three to four hours (till the digested contents attained transparent color). Then digested material was allowable on the way to cool at room temperature and diluted to a final volume of 50 ml. The ammonia trapped in H_2SO_4 was liberated through addition 40% NaOH solution through distillation and collected in a flask containing 4% boric acid solution, possessing methyl indicator and titrated against standard 0.1 N H_2SO_4 solutions.

Calculation:

% Total Nitrogen =14.01 x (sample titre – blank titre) x N/ 10 X sample weight

N = Normality of acid

I.e. protein (crude) =% Nitrogen X Conversion factor (6.25)

2.2. Microbiological analysis

Samples preparation

Preparation of samples determined according to (ISO/6887-1/1999).

2.2.1. Total plate count

This was determined according to (ISO 4833/2013).

2.2.2. Mold and yeast counts

This was determined according to (ISO 21527-2/2009).

2.2.3. Coliform group count

This was determined according to (ISO 4832:2006).

2.2.5. Staphylococcus aureus

This was determined according to (ISO 6888-1/ 2003). **2.2.6. Enterobacteriaceae**

This was determined according to (ISO 21528- 2004).

2.2.7. E. coli

This was determined according to (ISO 16649-2/ 2001). **2.2.8. Salmonella**

This was determined according to (ISO 6579/ 2002).

2.2.9. Air sampling

Air samples were taken from high hygiene zone where the petri dish has solid media. L of air for 10 min on the petri dish then petri dishes having solid media was incubated on proper temperature for every one microorganism).

2.3. PRPs for HACCP implementing

2.3.1. Location design area for the smoking factory

The factory is allocated into three areas high, medium, basic hygiene area, depended into area require-

ments for each area. Monitoring procedure for pathogen will be recognized in high hygiene zone. A complete descripting of cold smoked herring fish processing and packaging starting from receiving of raw materials, storage...etc. The flow chart was made by all HACCP members as shown in Figure (1).

2.3.2. Suppliers of raw materials receiving procedure

Herring, salt, sawdust and packaging materials were obtained from approved suppliers. Fish and salt were analyzed. Samples were taken by trained laborers for microbiological examinations to confirm their safety based on specific standards.

2.3.3. Water supply

It must be potable water, and it must be analyzed microbiological, chemical and physical tests every year to ensure there are no risks on it according to Egyptian standard for drinking water. (E.S 190-1 / 2007).Water supply pipes must be separated from sewage pipes, and this must be noticed by color.

2.3.4. Cleaning and sanitizing procedure

All the factory area must be put in cleaning program and plan. By the instructions that put to make workers who only do this job, apply cleaning program and plan well. Cleaning type and cleaning frequency different between Dry cleaning and wet cleaning according to the area that is been cleaned. All cleaning and sanitizing chemicals must be received with two file papers for attach other Material safety data sheets (MSDS) and technical data sheets (TDS). Material safety data sheets (MSDS) explain that chemical products are available to use in food factory industry. Technical data sheets (TDS) were explained the best way for using them to do the process of cleaning well. All of these chemicals were visibly labeled and put in storage in protected region with limited access. Cleaning process has done daily, weekly, monthly depend on the place and the type of the process that done.

2.3.5. Individual hygiene procedure

The swabs examinations were taken before implementing and after implementing clean both hands from worker hands to make sure that staff complies with individual hygiene procedure. There are others programs for PRPs list as shown in Table (1).

2.3.6. Training procedure and plan

All staff must be trained continuously according to their jobs and this is documented in training plan record. Materials for each training programs, lists of staff who trained must be documented also.

2.4. Sensory assessment of final cold smoked herring

Cold smoked herring fish sensory assessment was evaluated for skin condition, taste, flavor, color and odor of fish flesh (Stone and Sidel, 2004).

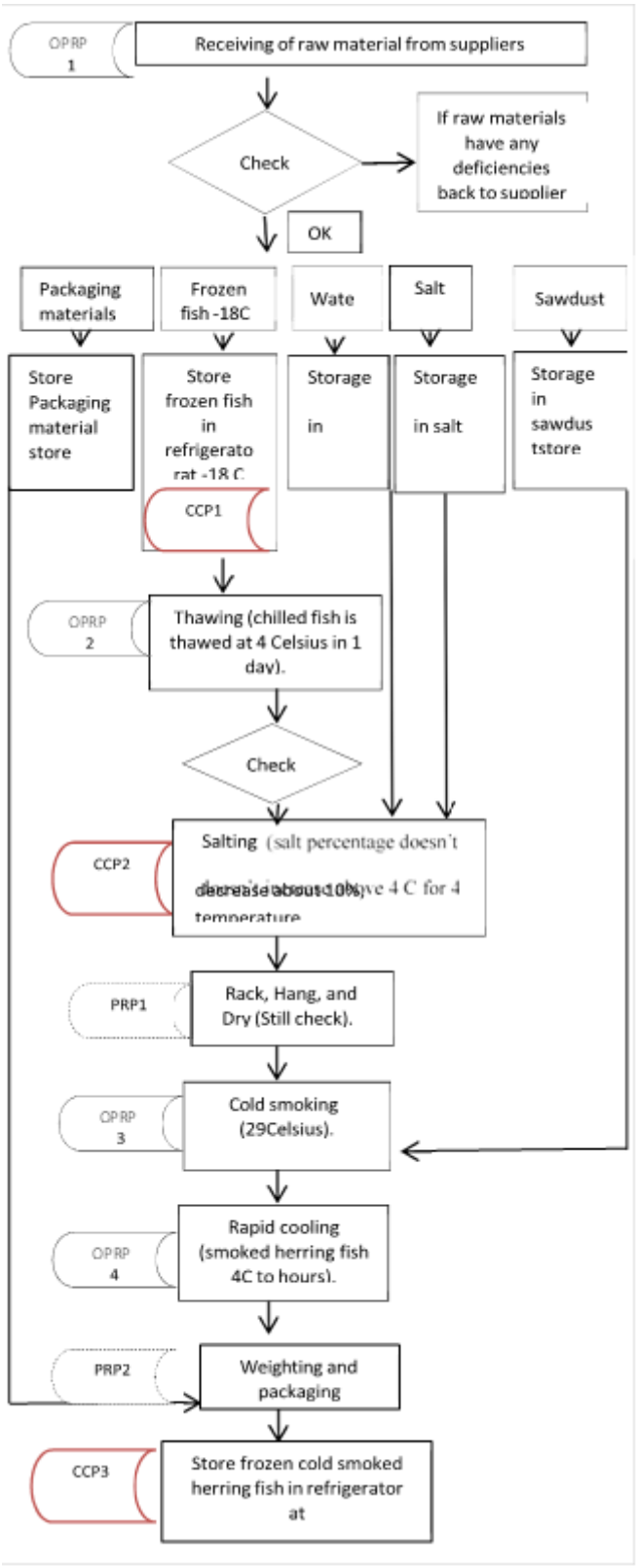

Table (1): list of Prerequisite programs (PRPs).

Prerequisite Programs (PRPs): programs, plans and Procedures which are disconnected from the HACCP plan, but which are necessary to the efficiency of the HACCP plan. PRPs are a serious portion of any food production process. PRPs include GMP and GHP (Ramful and Menon, 2017).	**Good manufacturing practices (GMPs)**	Management approach and process controls (Varzakas, 2016). Deal with: -Purchasing Specification. -Suppliers of raw materials. -Calibration of instruments. -Equipment. -Traceability and recall. -Equipment designs. -Maintaining and monitoring. -Light and aeration systems. -Storage settings -Control of operations.
	Good hygiene practices (GHPs)	System for maintaining hygiene. (Ramful and Menon, 2017). Regards: -Individual hygiene. -Worker health. -Working environments. -Factory and equipment maintenance. -Food contact surfaces hygiene. -Pest control. -Waste removal. -Water quality. -Toilet and hand wash services. -Cross contamination prevention.

3. Results and discussion

1. PRPs for HACCP implementing

Ways control of the operating environments within the fish smoked factory, tolerating for ecofriendly conditions which are beneficial for harmless and healthful smoked fish industrialized. Procedures whish was ordinarily in apartment previously the HACCP plan is established due to make sure the industry is in work agreeing to Codex common principles for food hygiene and food safety legislation (ISO 22004, 2014 and SCV, 2006).

1.1. Factory area lay out

The air was clarified and checked by air sampling in the high hygiene area that according to applying of microbiological plans to check the air conditions effectiveness. Air sampling testing was taken to assess the microbiological contents of the air surrounding not the same locations of packaging line high hygiene area. The gotten results are exposed in Table (2). Results shown which the air subsequently applying hygienic requests of area by filtrated air was not having any pathogenic microorganisms and has low bacteria and yeast & mold microbial load counts but the air of the same area previously applying hygienic requests were having high bacteria and yeast & mold microbial load counts. Corrective action essential must be occurred through inspection air filter, maintaining or changing filter if essential. Retraining for persons and then make a test again and this becomes necessary. Results were getting in agreeing with (Forsythe and Hayes, 1998 and Khatab Heba, 2014)

1.2. Suppliers of receiving raw materials

Raw materials like frozen herring fish, salt and water were been tested microbiology and chemicals to make sure that all safe and to ensure that final products (cold smoked herring fish) safe and edible for use by customers. According to ISO 5928, the samples were taking. The results made known in Tables (3) and (5) we could find which samples of raw materials (frozen herring fish and salt) were surrounded by the limits of Egyptian standard for frozen fish (E.S: 899-1 /2005) and thus received batches were accepted. In case of deviation from the limits, it is excluded and pays back to the supplier again

Table (2): Biological examination high hygiene area previously and afterward applying hygienic requests (air random sample swabs)

zone	T	Microbial count (Colony form unit/ plate =cfu/ plate)			
		Total Plate counts	**Mold & yeast**	***Staphy. aureus***	***Total Coli-forms Count***
Limit	--	< 50	< 30	-	-
1	A	180[a]	90[a]	-	-
	B	30[de]	18[d]	-	-
2	A	135[b]	63[b]	-	-
	B	18[e]	18[d]	-	-
3	A	68[c]	40[c]	-	-
	B	13[e]	13[d]	-	-

*The limits are agreeing to internal specifications.
*Values shadowed through different letter in columns were significantly different at p <0.05.
*T=Time of taking sample. *1=Front, 2=Middle, 3= Ends * A = Before, B= After. * - = Not detected.

Table (3): Frozen herring fish microbiological analysis

Test to be analysed	Results	Accepted limits
Coagulase positive Staphylococcus	< 10 cfu/gm	Less than 10^3 cfu/gm
E.coli count	< 10 cfu/gm	Not detected
Vibrio Sp.	< 10 cfu/gm	Not detected
Total Aerobic Mesophilic Bacteria Count	(3.7×10^3) ±1.4 cfu/gm	Less than 10^3 cfu/gm
Salmonella	Not detected in 25 gm	Not detected

*The results less than 10 cfu/gm mean not detected according to test method Procedure.

Table (4): Microbiological analysis of water

Test to be analysed	Results	Accepted limits
Enumeration of microorganisms at 22˚C	< 1.0 ±0.016 [long 10 (cfu/ml)]	< 50 cfu/ml
Enumeration of microorganisms at 37˚C	< 1.0 ±0.014 [long 10 (cfu/ml)]	< 50 cfu/ml
Detection & Enumeration of the coliforms group-MPN	< 1.0 ±0.0106 [long 10 (cfu/100ml)] Not detected	Not detected in 100 ml
Detection & Enumeration of the E. coli - MPN	< 1.0 ±0.0160 [long 10 (cfu/100ml)] Not detected	Not detected in 100 ml
Enumeration of Enterococcus	< 1.0 ±0.0157 [long 10 (cfu/100ml)] Not detected	Not detected in 100 ml
Enumeration of Fecal streptococcus groups	< 1.0 ±0.0157 [long 10 (cfu/100ml)] Not detected	Not detected in 100 ml
Detection of protozoa in drinking water	Not detected	Not detected
Detection of algae in drinking water	Not detected	Not detected

Table (5): Microbiological analysis for salt

Test to be analysed	Results	Accepted limits
Enumeration of Coagulase positive Staphylococci (Staphylococcus aureus and other spp.)	< 10 ±0.018 [long 10 (cfu/g)] not detected	< 50 cfu/ml

1.3. Water supply

The water was tested to make sure it is potable for human consumption, to act in accordance with the Egyptian standard. The water used for work and drinking was free from the pathogen and total plate count at 22 and 37ºC within limits such as made known in Table 4. Correction and preventive action should be occupied in the way of deviation results of out of limits examination. These corrective actions maybe done through changing filters or filters maintenance, water reservoirs. Results were in agreement with, (Easdani et al., 2012). Method is done in accordance with (ISO 9308-1/2000).

1.4. The program of cleaning and sanitizing

Visual inspection was done, after Appling cleaning plan. Cleaning efficiency was monitored, checked and results recognized. Table (6) appearances tests results of microbiology examination of swabs were in use from different equipment from the salting and packing lines before and after the application of the cleaning and sanitizing programs. The significant was decrease in total plate count can be experimental obviously; by way of no pathogen's microbes (Staphylococcus aureus, Total plate count, Total coliform count, Mold & yeast) and all microorganisms have been reduced to safe level after applying cleaning and sanitizing programs. In case of deviation and the results out of the limits corrective action should be taken by re-cleaning, re-using of sanitizer for a second time, training for how to do well cleaning and sanitizing program, awareness of workers and re-swab and retest for a second time. The production processing is not beginning work if the results surrounded by acceptable limits.

Our results in agreeing with (Forsythe, 2012 and Khatab Heba, 2014) who informed which standard number of good microbial load of spoilage microorganisms of food contact surfaces ranged between 2-10/cm2 though the safe microbial load number is less than 1/cm2. It was clear which there not control in this apartment was already previously applying cleaning and sanitizing programs. Cleaning system was been poor in food contact equipment and control not been effective so it was important to do corrective action to make sure that food safety applied in the products.

1.5. Individual hygiene

Table (7) is explained swabs microbiological examination results had been taken previously and subsequently implementing workers hygiene from salting processing line and packaging line to assess worker hygiene and make sure the efficiency cleaning and sterilization program for employees. The results were shown high infection with total plate count by means of the presenting of pathogenic microorganisms (Staphylococcus aureus, Total plate count, Total coliform count, Mold & yeast) before cleaning & disinfecting of hands. Then after applying active hand washing procedure, swabs results were occupied within the standard limit for totally staff workers. Corrective action should be occupied when deviation occur through re-training employee and re-swabbing for a second time.

1.6. Training procedure

Before the ending of the year, every department makes a list of number and names of worker staff they need to be trained and the name of the training course to put the new plan of training with beginning of New Year. Training is needed to efficiently implement the required doings in the establishment food safety strategy (ISO/TS 22002-1, 2009).

2. Cold smoked herring final products description

A totally product description, as well as significant safety data like: chemical composition, physical structure and microbiological characteristics. Packaging materials and Ingredients used for cold smoked herring fish and the intending use of these products are pronounced in Table (8). As careful compared to the following headlines and documented as HACCP studying summaries (SCV, 2006).

Table (6): Microbiological analysis of swabs taken from equipment's of salting processing and packaging stages before and after implementing of the program of cleaning and sanitation

Equipment	Test & limit	Before	After
Salting basin	Total Plate count (1000 cfu/ swab)	1.9×10^{5a}	4.3×10^{2b}
	Mold & yeast (Nil/ swab)	1.8×10^{3a}	Nil
	Staphylococcus aureus (Nil/ swab)	Detected	Nil
	Total Coliforms count (Nil/ swab)	Detected	Nil
Washing salting basin	Total Plate count (1000 cfu/ swab)	5.9×10^{5a}	3.1×10^{2b}
	Mold & yeast (Nil/ swab)	1.7×10^{4a}	Nil
	Staphylococcus aureus (Nil/ swab)	Detected	Nil
	Total Coliforms count (Nil/ swab)	Detected	Nil
Stainless steel table packaging	Total Plate count (1000 cfu/ swab)	1×10^{4a}	2.6×10^{2b}
	Mold & yeast (Nil/ swab)	7.3×10^{2a}	Nil
	Staphylococcus aureus (Nil/ swab)	Detected	Nil
	Total Coliforms count (Nil/ swab)	Detected	Nil
Vacuum machine	Total Plate count (1000 cfu/ swab)	8.3×10^{4a}	2.2×10^{2b}
	Mold & yeast (Nil/ swab)	1.8×10^{3a}	Nil
	Staphylococcus aureus (Nil/ swab)	Detected	Nil
	Total Coliforms count (Nil/ swab)	Detected	Nil

* The limits are according to American public health association.

* Colony forming unite/ swab = cfu/ swab

* 1000 cfu/ swab = 1 cfu/100Cm^2

Table (7): Microbiological examination of swabs taken from workers for salting processing line and packaging line before and after wash and sanitizing the hands

Area	Test & limit	N	Before	After
Salting processing	Total Plate count (1000 cfu/ swab)	A	2.7 ×103	8 ×10
		B	8.6×103	3.6 ×10
		C	2.5 ×103	4.5 ×10
		D	8.1 ×103	3.6 ×10
	Mold & yeast (Nil/ swab)	A	45 ×102	Nil
		B	57×10	Nil
		C	64 ×10	Nil
		D	45×10	Nil
	Staphylococcus aureus (Nil/ swab)	A	Detected	Nil
		B	Detected	Nil
		C	Detected	Nil
		D	Detected	Nil
	Total Coliforms count (Nil/ swab)	A	Nil	Nil
		B	Detected	Nil
		C	Nil	Nil
		D	Detected	Nil
Packaging	Total Plate count (1000 cfu/ swab)	A	2.6 ×103	6.3×10
		E	4.3 ×103	1.2 ×102
		F	7.6×103	1.8×102
		G	1.5×104	2.7×102
	Mold & yeast (Nil/ swab)	H	3.6 ×102	Nil
		E	2.2 ×102	Nil
		F	7.2 ×10	Nil
		G	19 ×10	Nil
	Staphylococcus aureus (Nil/ swab)	H	Detected	Nil
		E	Detected	Nil
		F	Detected	Nil
		G	Nil	Nil
	Total Coliforms count (Nil/ swab)	H	Detected	Nil
		E	Detected	Nil
		F	Detected	Nil
		G	Detected	Nil

*1000 cfu/ swab = 1 cfu/100Cm^2. nil/ swab for Mold & yeast, Staphylococcus aureus and Total coliforms count. * N= abbreviation of worker name, each worker, swabs were taken for 4 tests.

Table (8): Cold smoked herring fish product description

<table>
<tr><th>Item</th><th>product description</th></tr>
<tr><td>Product name</td><td>Cold smoked herring fish product</td></tr>
<tr><td>Physical characteristics</td><td>Product should be free from rancidity, odour and golden in colour</td></tr>
<tr><td>Proximate analysis</td><td>
<table>
<tr><td>Parameter</td><td>Amount (gm.)</td></tr>
<tr><td>Protein</td><td>18.435</td></tr>
<tr><td>Lipid</td><td>5.45</td></tr>
<tr><td>Ash</td><td>4.99</td></tr>
<tr><td>Carbohydrate</td><td>0.505</td></tr>
<tr><td>Moisture content</td><td>68.95</td></tr>
</table>
</td></tr>
<tr><td>Microbiological characteristics</td><td>
<table>
<tr><td>Test to be analyzed</td><td>Results</td><td>Accepted limits</td></tr>
<tr><td>Coagulase positive Staphylococcus</td><td>< 10 cfu/gm</td><td>Less than 10^3 cfu/gm</td></tr>
<tr><td>Clostridium botulinum</td><td>< 10 cfu/gm</td><td>Not detected</td></tr>
<tr><td>Vibrio Sp.</td><td>< 10 cfu/gm</td><td>Not detected</td></tr>
<tr><td>Total Aerobic Meso-philic Bacteria Count</td><td>(2.3×103) ±1.4 cfu/gm</td><td>Less than 10^3 cfu/gm</td></tr>
<tr><td>Salmonella</td><td>Not detected in 25 gm</td><td>Not detected</td></tr>
<tr><td>Listeria Monocyto-genes</td><td>Not detected in 25 gm</td><td>Not detected</td></tr>
</table>
</td></tr>
<tr><td>Packaging</td><td>Renga put in wooden boxes</td></tr>
<tr><td>Processing method</td><td>No thermal treatment</td></tr>
<tr><td>Shelf life</td><td>2 months</td></tr>
<tr><td>Storage condition and delivery method</td><td>-18 C temperature degree</td></tr>
<tr><td>How to use the product</td><td>Ready - to - eat</td></tr>
<tr><td>Target group</td><td>For all people expect who has allergy</td></tr>
<tr><td>Labelling instructions</td><td>Weight – production date- expired date – storage instruction – nutritional value.</td></tr>
</table>

Table (9): Microbiological, chemical analysis and sensory evaluation for Cold smoked herring final product.

Parameter	**Test to be analyzed**	**Limit**	**Results**
Microbiological analysis	Coagulase positive Staphylo-coccus	Less than 103 cfu/gm	< 10 cfu/gm*
	Clostridium botulinum	Not detected	< 10 cfu/gm*
	Vibrio Sp.	Not detected	< 10 cfu/gm*
	Total Aerobic Mesophilic Bacteria Count	Less than 103 cfu/gm	(2.3×103) ±1.4 cfu/gm
	Salmonella	Not detected	Not detected in 25 gm
	Listeria Monocytogenes	Not detected	Not detected in 25 gm
Chemical analysis	Protein		18.435 %
	Lipid		5.45 %
	Carbohydrate		0.505 %
	Ash		4.99 %
	Moisture content		68.95 %
	Salt percentage		4.3%
Sensory evaluation	Color	≥ 5	9
	Taste	≥ 5	8
	Odor	≥ 5	8
	Texture	≥ 5	7
	Overall acceptability	≥ 5	8.5

*The results less than 10 cfu/gm mean not detected according to test method Procedure.

4. Conclusion

Implement ISO 22000, to create totally safe food production area, beginning with receiving of raw materials, then processing and finally distribution of final products. The microbiology tests for received raw materials (frozen fish, salt and water) were analyzed and their results with the limits of acceptance. Also, the system of cleaning and sanitation was implemented for all factory area, especially in production areas such as salting area and packaging area and for all staff of workers; this system is been effective as the results of microbiology test swabs (for production area, equipment and for hands of staff workers) that show the difference between results before and after implementing this system. Microbiology, chemical tests and sensory evaluation were analyzed at the final product that ready – to – eat.

5. References

A.O.A.C. (2005). Association of Official Analytical Chemists Official Methods of Analysis of the Association of Official Analytical Chemists. 18th Ed. Washington, DC, USA.

Atef, S. O. (2013). Technological attempts for production of low sodium smoked herring fish (Renga). Advance Journal of Food Science and Technology,5,695-706.

Blackwell, W. (2014). Seafood Processing Technology, Quality and Safety. Chichester, UK: Institute of Food Science and Technology.

CODEX, A., & INTERGOVERNMENTAL, T. F. O. A. R. (2009). JOINT FAO/WHO FOOD STANDARDS PROGRAMME CODEX ALIMENTARIUS COMMISSION Thirty third Session Geneva, Switzerland, 5-9 July 2010. Codex.

Doe, P. E. (Ed.). (1998). Fish drying and smoking: Production and quality. CRC Press.

E.S: 288 (2005) Egyptian organization for standardization and quality for Smoked fish.

E.S: 899-1 (2005) Egyptian organization for standardization and quality for Frozen fish.

Easdani, M.; Khaliduzzaman and Bhuiyan, M. H. R. (2012) The Design of HACCP Plan for Potato Chips Plant in Bangladesh. J. Environ. Sci. & Natural Resources, 5 (2), 329 – 338.

ES: 190-1 (2007) Drinking water and ice standard test method part -1.

ES: 2732-1 (2007) Egyptian organization for standardization and quality for Sodium chloride.

Forsythe, S. (Ed.). (2012). Food hygiene, microbiology and HACCP. Springer Science & Business Media.

Forsythe, S. J. and Hayes, P. R. (1998). Food Hygiene, Microbiology and HACCP and product quality.3rd ed. Aspen Publishers, Inc. Gaithersburg, Maryland.

ISO 16649-2 (2001) International Standardization Organization. ISO 16649-2. Horizontal method for enumeration of B - glucronidase - positive E. coli colony count technique at 44°C - part 2 first edition.

ISO 21528-2 (2004) International Standardization organization ISO21528-2. Horizontal method for enumeration of detection enumeration of Enterobacteriaceae - part 2 third edition.

ISO 2157-2 (2008) International Standardization organization. ISO 2157-2. Horizontal method for enumeration of Molds yeast & colony count technique in products with water activity -<0.95- part 2.

ISO 22000 (2018). International standard organization ISO 22000. Food safety management systems-Requirements for any organization in the food chain second edition

ISO 48332 (2006) International standardization ISO 4833. Horizontal method for enumeration of coliforms- colony count technique.

ISO 6579 (2002) International Standardization organization ISO 6579. Horizontal method for detection of salomonella spp- fourth edition.

ISO 6887-1 (1999) International Standardization organization ISO 6887-1. General rules preparation of test sample, initial suspension & decimal dilutions for microbiological examination- part 1

ISO 6888-1 (2003) International Standardization Organization ISO 6888-1. Horizontal method for enumeration of Staphylococcus aureus-part1.

ISO 9308-1 (2000) International Standardization Organization.ISO 9308. Water quality detection &enumeration of E. coli & coliform bacteria membrane filtration- part1.

ISO9308-1/ (2000). International Standardization Organization.ISO9308. Water quality detection &enumeration of E. coli& coliform bacteria part-1 membrane filtration.

ISO-TS22002-1 (2009) International Standardization Organization ISO-TS22002-1. Prerequisite programmes on food safety Part 1- Food manufacturing.

Kari, Z. A., Kabir, M. A., Razab, M. K. A. A., Munir, M. B., Lim, P. T., & Wei, L. S. (2020). A replacement of factory protein sources as an alternative of fish meal ingredient for African catfish, Clarias gariepinus: A review. Journal of Tropical Resources and Sustainable Science (JTRSS), 8(1), 47-59.

Khatab, Heba, A. (2014) Controlling of microbial hazard during the processing of mango pulp and juice through food safety management system (ISO 22000). MSc. Thesis, Food science and technology Depart., Fac. of Agric. Tanta Univ.

Khoshmanesh, S. (2006, August). Design of solar dehydrator, coupled with energy storage in rock bed reservoir for fish drying process. In International Conference on Energy and Environment (ICEE), Universiti Tenaga Nasional, Bangi, Selangor, Malaysia (Vol. 28, pp. 1-8).

Mishra, S. P., & Pradesh, U. (2020). Significance of fish nutrients for human health. International Journal of Fisheries and Aquatic Research, 5(3), 47-49.

Ramful, K., & Menon, H. (2017). Food Safety and Good Hygiene Practices Handbook for Gambian Youth Entrepreneurs. Geneva: International Trade Centre.

SCV (2006) Requirements for a HACCP based Food Safety, Option A: Management System Certification. National Board of Experts-HACCP. The Netherlands.

Stone, H., & Sidel, J. L. (2004). Introduction to sensory evaluation. Sensory evaluation practices, 3, 1-19.

Tenyang, N., Tiencheu, B., & Womeni, H.M. (2018). Effect of smoking and refrigeration on lipid oxidation of Clupea harengus: A fish commonly consumed in Cameroon. Food Sciences and Nutrition, 6, 464-473.

Varzakas, T. (2016). HACCP and ISO22000: Risk assessment in conjunction with other food safety tools such as fmea, ishikawa diagrams and pareto